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(54) IMPROVEMENTS IN OR RELATING TO SOLDERING IRONS

(71) We, THE GENERAL ELECTRIC COMPANY LIMITED, formerly The General Electric and English Electric Companies Limited, of 1 Stanhope Gate, London, W.1., a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to soldering irons, and more particularly to soldering iron bits.

As is well known, copper is suitable for use as a soldering iron bit material by virtue of its high thermal conductivity, but suffers from the disadvantage that it is liable to undergo rapid erosion by liquid solder of the tin-containing kind generally used. It has been proposed to provide copper soldering bits with a protective cladding of iron deposited, for example, by electroplating. The iron cladding prevents penetration of the tin, present in the solder, into the copper for a time; however, the iron is slowly eroded in use of the bit, and is eventually punctured, whereupon rapid erosion of the underlying copper occurs and the bit becomes useless.

It is an object of the present invention to provide soldering iron bits having improved resistance to erosion by tin-containing solder.

According to the invention, a soldering iron bit is composed of an alloy consisting substantially of copper and iron, containing from 5% to 60% by weight of iron, and consisting of at least two mutually insoluble phases at least one of which is copper-rich and at least one of which is iron-rich, which phases are present in the form of elongated particles or regions and are interlocked with one another so as to impart a fibrous structure to the alloy body.

Usually the alloy consists of one copper-rich phase and one iron-rich phase, but with some alloy compositions, and under some conditions of preparation of the alloy, more than two phases may be obtained. The copper-rich phase provides a path for good conduction of heat to the working tip of the soldering iron bit in operation, and the iron-rich phase affords protection for the copper-rich phase against erosion by the solder. Preferably the proportion of iron present in the alloy is sufficiently high to enable the elongated particles or regions of the iron-rich phase to form substantially continuous multiple protective layers, between layers of the copper-rich phase, throughout the bit; however it is also desirable that the proportion of iron is not so high as to prevent adequate heat conduction through the copper-rich phase. Suitable weight ratios of iron to copper in the alloy are, for example, in the range of 20:80 to 50:50.

The word "substantially", as used above with reference to the composition of the alloy

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of which the soldering iron bit of the invention is composed, means that the alloy either consists of copper and iron only, as is preferred, or consists of copper and iron with small amounts of one or more other elements, which might be included in some cases either as impurities or as deliberate additions. For example, one or more of the elements phosphorus, chromium, nickel, silicon, may be present. To ensure that these additions or impurities have little deleterious effect on either the thermal conductivity of the copper-rich phase or the protective effect of the iron-rich phase, the total amount of such additional elements present should not exceed 2% by weight of the alloy.

In consequence of the presence of an iron-rich phase throughout a soldering iron bit in accordance with the invention, erosion of a surface layer of copper-rich material does not result in catastrophic failure of the bit, since rapid penetration of the erosive agent, such as tin, further into the bit is prevented by the protective layers of iron-rich material. The useful lives of such bits are thus considerably prolonged by the presence of the iron therein. Furthermore, when a bit becomes worn as a result of erosion of copper-rich surface regions, the tip of the bit can readily be reformed by filing or grinding. A further advantage of the bits of the invention, as compared with iron-plated copper bits, is relatively low cost of production.

A copper-iron alloy for use in the manufacture of soldering iron bits in accordance with the invention can be produced by a conventional melting or powder metallurgical process, followed by working to give the multi-phase alloy the required fibrous structure. A preferred method of preparing the alloy comprises isostatically pressing a mixture of iron and copper powders in the required relative proportions, suitably under a pressure of 20—25 tons per square inch, and sintering the compact so formed by heating it in hydrogen at a temperature in the range of 950°C to 108°C, for example at 1000°C for 24 hours; the particle size of the metal powders is not critical, but preferably the powders are sufficiently fine to pass through a sieve having 100 to 200 meshes to the linear inch. Alternatively, the alloy may be prepared by melting the requisite proportions of iron and copper together with thorough stirring, and casting the melt in a suitable mould. The sintered or cast product is finally subjected to a unidirectional rolling, swaging or drawing treatment to effect elongation of the particles or regions of copper-rich and iron-rich phases; in order to attain the desired fibrous structure, the alloy body is suitably reduced, by such working, to a cross-sectional area which is less than 50% of its initial cross-section.

The alloy could alternatively be produced with the required fibrous structure by an extrusion process, the alloy being prepared by melting copper and iron together, or by sintering, and the solidified melt or sintered body being extruded either hot or cold, with or without further working.

Since the solubilities of iron and copper in each other vary with temperature, as is known, the compositions of the iron-rich and copper-rich phases respectively vary according to the temperature employed for the preparation of the alloy. For example, in an alloy prepared by sintering at 1000°C, the copper-rich phase contains 2.9% of iron and the iron-rich phase contains up to 8% of copper, by weight.

Soldering iron bits of the required size and shape are formed from a body of an alloy, produced by any of the methods referred to above, by conventional machining or forming techniques.

A specific method which we have employed for the manufacture of soldering iron bits in accordance with the invention will now be described by way of example, with reference to the drawing accompanying the Provisional Specification.

In the method of the example, a 50:50 copper-iron alloy was prepared by mixing equal weights of copper powder and iron powder, compacting the powder mixture under hydrostatic pressure of 25 tons per square inch to form rods 3 cm in diameter, and sintering the rods by heating in hydrogen at 1000°C for 24 hours. The sintered alloy rods thus produced were composed of a mixture of particles of an iron-rich phase and of a copper-rich phase.

The sintered rods were then cold-rolled down to bars 1 cm square, the cross-sectional area thus being reduced to 14.2% of that of the initial rods, and soldering iron bits were formed from the bars by machining.

The drawing is a reproduction of a photomicrograph, at a magnification of 100, of a section through part of the tip of a bit manufactured by the method of the example, taken after the bit had been in service for two months under conditions such that the bit attained a temperature of 400°C in operation. During this use, the thermal conductivity of the bit was found to be not significantly inferior to that of an iron-plated copper bit.

In the drawing, the white areas 1 shown in the body of the bit are a copper-rich alloy phase, and the light grey areas 2, interlocked with the white areas, are an iron-rich phase. The dark grey areas 3 consist of solder adhering to the surface of the bit, with some penetration into the copper-rich phase; 4 is an interaction zone in which copper-tin intermetallic compounds have been formed.

No serious erosion of the tip of the bit had occurred under the conditions of use referred to above, although it is apparent from the photomicrograph that some attack on the copper by tin had taken place, resulting in

the formation of intermetallic compounds, the iron-rich phase, however, being sufficiently continuous to inhibit this process to a large extent, and thus to prevent deep penetration of tin into the bit.

Similar results have been obtained with a soldering iron bit formed from an alloy consisting of 30% iron and 70% copper, by weight, manufactured by a method similar to that described in the above example in respect of the 50—50 alloy.

WHAT WE CLAIM IS:—

1. A soldering iron bit which is composed of an alloy consisting substantially, as hereinbefore defined, of copper and iron, containing from 5% to 60% by weight of iron, and consisting of at least two mutually insoluble phases at least one of which is copper-rich and at least one of which is iron-rich, which phases are present in the form of elongated particles or regions and are interlocked with one another so as to impart a fibrous structure to the alloy body.

2. A soldering iron bit according to Claim 1, wherein the weight ratio of iron to copper in said alloy is in the range of 20:80 to 50:50.

3. A method of manufacturing a soldering iron bit according to Claim 1 or 2, which includes the steps of producing a said multi-phase copper-iron alloy by a melting or powder metallurgical process, working the alloy body to impart to it the required fibrous structure, and forming the bit from the worked alloy body.

4. A method according to Claim 3, wherein the alloy is produced by compacting a mixture of copper and iron powders in the required relative proportions under isostatic pressure of 20 to 25 tons per square inch, and sintering the compact so formed by heating it in hydrogen at a temperature in the range of 950°C to 1080°C.

5. The method according to Claim 4, wherein the copper and iron powders employed are sufficiently finely divided to pass through a sieve having 100 to 200 meshes to the linear inch.

6. The method according to Claim 3, 4 or 5 wherein, for imparting a fibrous structure to the alloy, an alloy body formed by casting a copper-iron melt or sintering a compacted copper-iron powder mixture is subjected to unidirectional rolling, swaging or drawing, to reduce the alloy body to a cross-sectional area which is less than 50% of its initial cross-sectional area.

7. A method according to Claim 3, wherein the alloy is prepared by melting copper and iron together in the required relative proportions, or by sintering, and then extruding to impart a fibrous structure thereto.

8. A method of manufacturing soldering iron bits composed of a copper-iron alloy, carried out substantially as hereinbefore described by way of example, with reference to the drawing accompanying the Provisional Specification.

9. A soldering iron bit manufactured by the method according to Claim 8.

10. A soldering iron fitted with a soldering iron bit according to Claim 1, 2 or 9.

For the Applicants,
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1284994 PROVISIONAL SPECIFICATION
1 SHEET
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